UNIT 4

# CHEMICAL EQUATIONS & STOICHIOMETRY

NAME: _____

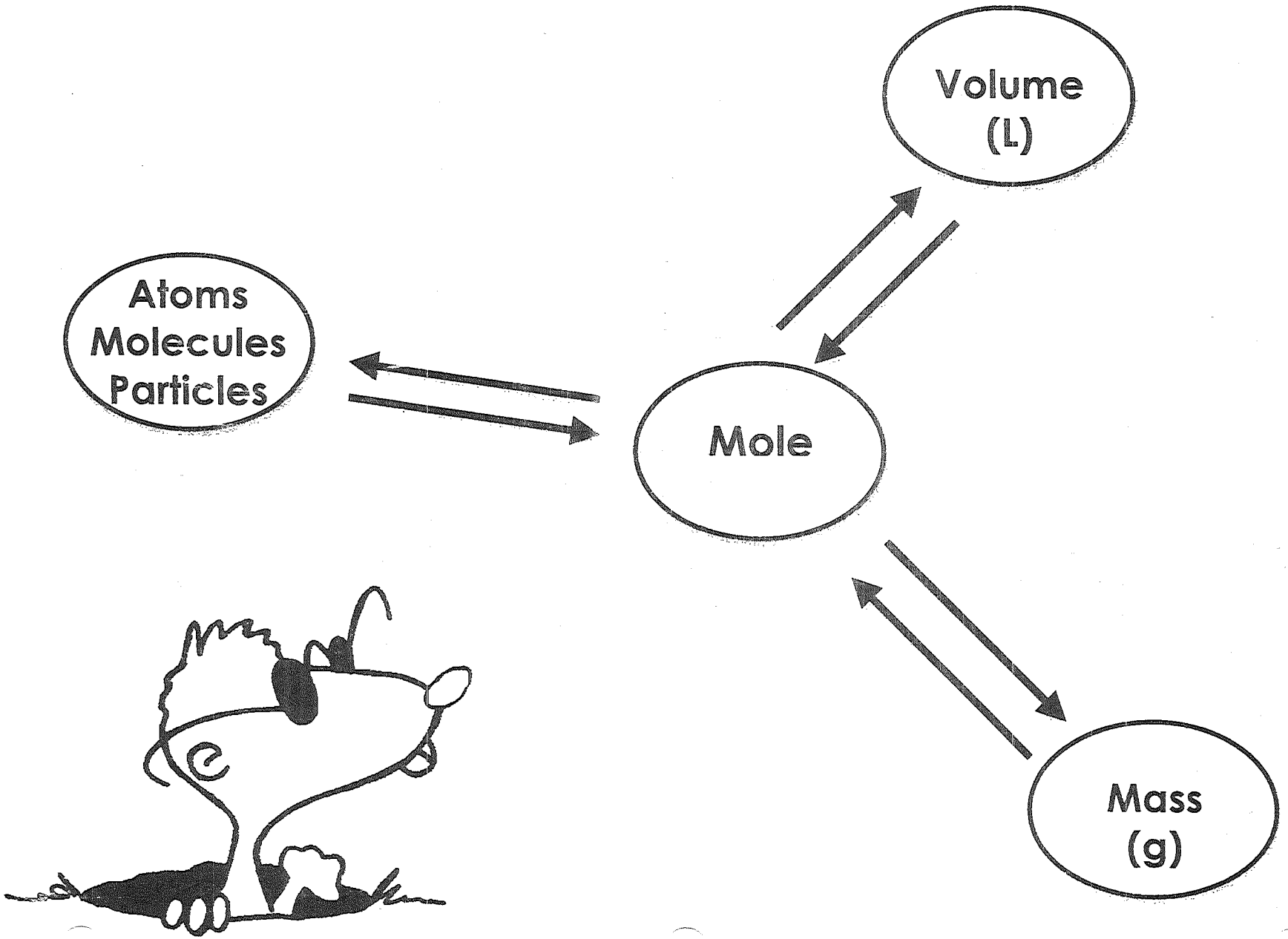
# Unit 4: Chemical Equations and Stoichiometry

Estimated Time: 15 hours

*In relation to this organizer, it is expected that students will explain transformations in matter and energy that occur during chemical reactions. Write and classify balanced chemical equations. Use mole ratios from balanced equations to calculate quantities of materials produced and consumed. Determine limiting and excess reagents, and use theoretical and experimental yields to calculate percent yields.*

| | |
|---|---|
| **J: Chemical Equations** | J1. balance formula equations<br>J2. apply the law of conservation of mass to explain chemical reactions in terms of the rearrangement of atoms<br>J3. translate word equations into formula equations<br>J4. use subscripts (*s*, *l*, *g*, *aq*) to represent solids, liquids, gases, and aqueous<br>J5. classify and predict the products of reactions involving synthesis, decomposition, single replacement, double replacement, acid-base neutralization, and combustion of $C_xH_y$ and $C_xH_yO_z$ compounds |
| **K: Energy Change in Chemical Reactions** | K1. classify reactions as exothermic or endothermic based on experimental observations<br>K2. use collision theory to explain that a chemical reaction is the result of a successful collision that can occur only when there is sufficient kinetic energy and correct geometry<br>K3. use PE diagrams to show the potential energy barrier to all reactions and relate this to activation energy ($E_a$)<br>K4. use PE diagrams to compare endothermic and exothermic reactions in terms of change in enthalpy ($\Delta H$)<br>K5. include an energy term (kJ) in chemical equations and relate this to the change in enthalpy ($\Delta H$)<br>K6. state that exothermic reactions have a strong tendency to be spontaneous, while endothermic reactions have a strong tendency to be non-spontaneous |
| **L: Stoichiometry** | L1 calculate moles of product formed given moles of one reactant and an excess of another reactant<br>L2. perform calculations related to chemical reactions using any of the following:<br>- moles<br>- mass<br>- gas volume at STP<br>- solution concentration and volume<br>L3. identify the excess reagent in a reaction and calculate the amount by which is in excess<br>L4. identify the limiting reagent in a reaction and use this value to determine the theoretical yield<br>L5. determine the experimental yield of a reaction in a laboratory setting<br>L6. calculate the percent yield of a reaction |

Mole Conversions



4.1 Balancing Equations Chemistry 11 - Mrs. Dildy

1. ____ $KNO_3$ → ____ $KNO_2$ + ____ $O_2$

2. ____ $CaC_2$ + ____ $O_2$ → ____ Ca + $CO_2$

3. ____ $C_5H_{12}$ + ____ $O_2$ → $CO_2$ + ____ $H_2O$

4. ____ $K_2SO_4$ + ____ $BaCl_2$ → ____ KCl + ____ $BaSO_4$

5. ____ KOH + ____ $H_2SO_4$ → ____ $K_2SO_4$ + ____ $H_2O$

6. ____ $Ca(OH)_2$ + ____ $NH_4Cl$ → ____ $NH_4OH$ + ____ $CaCl_2$

7. ____ C + ____ $SO_2$ → ____ $CS_2$ + ____ CO

8. ____ $Mg_3N_2$ + ____ $H_2O$ → ____ $Mg(OH)_2$ + ____ $NH_3$

9. ____ $V_2O_5$ + ____ Ca → ____ CaO + ____ V

10. ____ $Na_2O_2$ + ____ $H_2O$ → ____ NaOH + ____ $O_2$

11. ____ $Fe_3O_4$ + ____ $H_2$ → ____ Fe + ____ $H_2O$

12. ____ Cu + ____ $H_2SO_4$ → ____ $CuSO_4$ + ____ $H_2O$ + ____ $SO_2$

13. ____ Al + ____ $H_2SO_4$ →____ $H_2$ + ____ $Al_2(SO_4)_3$

14. ____ $Si_4H_{10}$ + ____ $O_2$ → ____ $SiO_2$ + ____ $H_2O$

15. ____ $NH_3$ + ____ $O_2$ → ____ $N_2H_4$ + ____ $H_2O$

16. ____ $C_{15}H_{30}$ + ____ $O_2$ → ____ $CO_2$ + ____ $H_2O$

17. ____ BN + ____ $F_2$ → ____ $BF_3$ + ____ $N_2$

18. ____ $CaSO_4$ $2H_2O$ + ____ $SO_3$ → ____ $CaSO_4$ + ____ $H_2SO_4$

19. ____ $C_{12}H_{26}$ + ____ $O_2$ → ____ $CO_2$ + ____ $H_2O$

20. ____ $C_7H_6O_3$ + ____ $O_2$ → ____ $CO_2$ + ____ $H_2O$

4.2 Writing and Balancing Equations Chemistry 11 – Mrs. Dildy

Complete and balance the following equations for which the correct word equations is given.

1. Iron + sulphur ➔ Iron (II) sulphide

_____

2. Iron + oxygen ➔ Iron (III) oxide

_____

3. Magnesium + oxygen ➔ magnesium oxide

_____

4. Sodium chlorate ➔ sodium chloride + oxygen

_____

5. Aluminum + sulphuric acid ➔ aluminum sulphate + hydrogen

_____

6. Copper (II) oxide + hydrogen ➔ copper + water

_____

7. Sodium Hydroxide + carbon dioxide ➔ sodium carbonate + water

_____

8. Magnesium bromide + chlorine ➔ magnesium chloride + bromine

_____

9. Carbon + steam ➔ carbon monoxide + hydrogen

_____

10. Iron + hydrochloric acid ➔ Iron (II) chloride + hydrogen

_____

11. Zinc + lead (II) acetate ➔ lead + zinc acetate

_____

12. Calcium hydroxide + ammonium sulphate ➔ calcium sulphate + ammonia + water

_____

13. Tin (IV) oxide + carbon ➔ tin + carbon monoxide

_____

14. Magnesium hydroxide + nitric acid ➔ magnesium nitrate + water

_____

15. Hydrogen + nitrogen ➔ ammonia

_____

16. Ammonia + oxygen ➔ nitric acid + water

_____

17. Calcium chloride ➔ calcium + chlorine

_____

18. Zinc + mercury (II) nitrate ➔ zinc nitrate + mercury

_____

19. Ammonium hydroxide + aluminum chloride ➔ aluminum hydroxide + ammonium chloride

_____

20. Copper (II) oxide + ammonia ➔ copper + water + nitrogen

_____

4.3 Writing and Balancing Equations Chemistry 11 – Mrs. Dildy

**Write a balanced chemical equation for each of the following:**

1. Sulfuric acid reacts with sodium hydroxide to give sodium sulfate and water.

_____

2. Sodium hydrogen carbonate reacts with sulfuric acid to produce sodium sulfate, water and carbon dioxide.

_____

3. Aluminum oxide and sulfuric acid produce water and aluminum sulfate.

_____

4. Sodium metal reacts with water to produce sodium hydroxide and hydrogen gas.

_____

5. The hydrocarbon, heptane ($C_7H_{16}$) burns in an atmosphere of oxygen to form carbon dioxide and water.

_____

6. Nitrogen trifluoride and hydrogen react to form nitrogen and hydrofluoric acid.

_____

7. Calcium carbonate and hydrogen chloride react to form carbon dioxide, calcium chloride and water.

_____

8. Boron trichloride reacts with steam to yield boron trihydroxide and hydrogen chloride.

_____

9. Calcium hydride and water form hydrogen and calcium hydroxide.

_____

10. Xenon hexafluoride reacts violently with water to form xenon trioxide and hydrogen fluoride.

_____

4.4 Types of Chemical Reactions

| Type of Reaction | Description | General Form/Example |
|---|---|---|
| Synthesis | | |
| Decomposition | | |
| Single Replacement | | |
| Double Replacement | | |
| Acid-Base | | |
| Combustion | | |

4.5 Classifying Reactions and Balancing Equations Chemistry 11 – Mrs. Dildy

Classify each chemical reaction:

synthesis
decomposition
single replacement
double replacement
combustion
acid-base

Balance the equation using the simplest whole number.

_____ 1. ___Cu(s) + ___$O_2$ (g) → ___CuO(s)

_____ 2. ___$H_2O$(l) → ___ $H_2$ (g) + ___ $O_2$ (g)

_____ 3. ___ Fe (s) + ___ $H_2O$ (l) → ___ $H_2$ (g) + ___ $Fe_3O_4$ (s)

_____ 4. ___ $AsCl_3$ (aq) + ___ $H_2S$ (aq) → ___ $As_2S_3$ (s) + ____ HCl (aq)

_____ 5. _____$CuSO_4$ $5H_2O$ (s) → ___ $CuSO_4$ (s) + ___ $H_2O$ (l)

_____ 6. ___ $Fe_2O_3$ (s) + ___ $H_2$ (g) → ___ Fe (s) + ___ $H_2O$ (l)

_____ 7. ___ $CaCO_3$ (s) → ___ CaO (s) + ___ $CO_2$ (g)

_____ 8. ___ Fe (s) + ___ $S_8$ (s) → ___ FeS (s)

_____ 9. ___ $H_2S$ (aq) + ___ KOH (aq) → ___ HOH (l) + ___ $K_2S$ (aq)

_____ 10.___ NaCl (l) → ___ Na (l) + ___$Cl_2$ (g)

_____ 11.___Al (s) + ___ $H_2SO_4$ (aq) → ___ $H_2$ (g) + ___ $Al_2(SO_4)_3$ (aq)

_____ 12.___ $H_3PO_4$ (aq) + ___ $NH_4OH$ (aq) → ___ HOH (l) +___ $(NH_4)_3PO_4$ (aq)

_____ 13.___$C_3H_8$ (g) + ___ $O_2$(g) → ___ $CO_2$ (g) + ___ $H_2O$(g)

_____ 14.___ Al (s) + ___ $O_2$ (g) → ___ $Al_2O_3$ (s)

_____ 15.___ $CH_4$ (g) + ___ $O_2$ (g) → ___ $CO_2$ (g) + ___ $H_2O$ (g)

4.6 Predicting Products

Chemistry 11 – Mrs. Dildy

**A. Complete each reaction:**

1. Reaction type: _____

   Balanced equation: _____ + _____ → _____

   Word equation: Sodium + chlorine → Sodium chloride

2. Reaction type: _____

   Balanced equation: ___ $K_2S$ (aq) + ___ $CuBr_2$ (aq) → ___CuS (aq) + ___ KBr (aq)

   Word equation: _____ + _____ → _____ + _____

3. Reaction type: _____

   Balanced equation: _____ + _____ → ___ $CO_2$ (g) + ___ $H_2O$ (g)

   Word equation: methane + oxygen → _____ + _____

4. Reaction type : _____

   Balanced equation: _____ → _____ + ___ $H_2$ (g)

   Word equation: ammonia → nitrogen + _____

5. Reaction type: _____

   Balanced equation: _____ + _____ → ___$H_2SO_4$ (aq)

   Word equation: sulfur trioxide + water → _____ + _____

**B. Predict the products, balance and classify each reaction.**

1. ____$Ag$ + ____$CuSO_4$ → _____ type : _____

2. ____$NaI$ + ____$CaCl_2$ → _____ type : _____

3. ____$Pb(NO_3)_2$ + ____ $K_2CrO_4$ → _____ type : _____

4. ____$HNO_3$ + ____$Mn(OH)_2$ → _____ type : _____

5. ____$AgNO_2$ + ____$BaSO_4$ → _____ type : _____

6. ____$HCN$ + ____$CuSO_4$ → _____ type : _____

7. ____$C_4H_8$ + ____$O_2$ → _____ type : _____

8. ____$HNO_3$ + ____$Fe(OH)_3$ → _____ type : _____

9. ____$LiBr$ + ____$Co(SO_3)_2$ → _____ type : _____

10. ____$LiNO_3$ + ____$Ag$ → _____ type : _____

11. ____$Zn$ + ____$Au(NO_2)_2$ → _____ type : _____

12. ____$C_6H_6$ + ____$O_2$ → _____ type : _____